Research Paper | Education | E-ISSN No : 2454-9916 | Volume : 9 | Issue : 8 | August 2023

THE MODERN CHALLENGE OF ENGINEERING FOR EXTENDED SPACE EXPLORATION

Daniel Minhyuk Lee

Research Scholars Program, Harvard Student Agencies, In Collaboration with Learn with Leaders

ABSTRACT

People have been trying to go further into space but failed to do so, only going so far to the moon as human beings. With just robots, humans were able to send it to Mars. Due to limited engineering, during space travel, it causes physiological distress significantly affecting the human brain and not having a spaceship fast enough to travel to another planet in the human lifespan, limiting long space exploration.

INTRODUCTION

The quest for knowledge and understanding has driven humanity to explore various frontiers, with space being one of the most enigmatic and fascinating domains. Amidst the vast expanse of stars, planets, and mysteries, our exploration has only extended as far as the moon, our closest satellite, and we are yet to venture to another planet. Numerous countries are diligently working to enhance their spaceships and programs, fueled by the aspiration to venture deeper into space, which has become a hallmark of their achievements. While the prospect of humans traveling further into space may seem feasible, the reality is that modern engineering poses significant challenges, making it currently unattainable. Such a journey would demand not only technological prowess but also confront mechanical and emotional obstacles that extend the timeline of exploration to well over a decade.

METHODOLOGY

This research draws upon a diverse array of resources, including research papers and articles, to substantiate the claims put forth in this study. Two resources were devoted to investigating the causes of brain and emotional damage, while six resources were utilized to explore the technological challenges involved. The incorporation of these resources aims to bolster the arguments made in this paper by citing relevant research and data from the field. Additionally, data pertaining to the solar system, distances between planets, and planetary environments have been considered to establish a strong connection with the thesis. The wealth of research and data collated from these resources serves to validate the existing challenges within modern engineering, lending credibility to the assertions made in this study.

The Challenges facing Human Health during Long Space Exploration

Challenges to human health are inevitable during extended space exploration missions. Research studies have revealed notable alterations in the human brain as a result of prolonged space travel, with MRI scans demonstrating structural changes in various parts of the brain and the nervous system (Roy-O'Reilly, Mulavara, & Williams). Additionally, the physiological toll of long space expeditions includes experiences of distress due to isolation and difficulties in adapting, which can lead to the development of emotional disorders.

1. Changes to the Human Brain

Long-duration space exploration exposes astronauts to microgravity, leading to significant structural changes in the human brain. Neuroimaging studies have revealed alterations in brain position, macrostructure, and the ventricular system, particularly the cerebrospinal fluid (CSF), as well as changes in gray matter (GM) and white matter (WM) composition. Research has shown differences between short-duration and long-duration astronauts, with long-duration missions resulting in an increase in ventricular volume. For instance, a 2017 study by Rober et al. demonstrated a 10.7% increase in ventricular volume in long-duration astronauts compared to short-duration ones (Roy-O'Reilly, Mulavara, & Williams). Even after 7 months post-flight, the ventricular volume remained significantly elevated compared to pre-flight measures. This increase in ventricular volume can disrupt CSF flow, compress surrounding brain tissue, and lead to various symptoms such as memory difficulties, motor control issues, headaches, and vision changes.

Moreover, brain imaging studies have revealed an increase in WM volume in astronauts with long-duration space exploration, persisting for up to 12 months post-flight (Roy-O'Reilly, Mulavara, & Williams). However, the impact of these changes on cognitive functions, sensorimotor integration, motor control, and visual processing requires further investigation.

While some may argue that humans can explore nearby planets, such as Mercury, the extreme heat close to the sun makes it challenging for spacecraft to withstand such conditions, and astronauts would face difficulty adapting to the environment (Kuthunur, n.d.). Similarly, a trip to Mars, taking over a year each way, poses significant challenges due to the prolonged duration in space and its potential impact on astronauts' health (Trip to Mars - NASA Mars, n.d.).

As of now, there are no definitive solutions to address the effects of long space exploration on human health. Modern technology does not yet allow humans to travel to distant planets like Mars or Mercury, making it crucial to continue research and advancements to better understand and mitigate the health challenges associated with extended space missions

2. Causes Stress Isolation

Long-duration space exploration, lasting around 12 months, can significantly impact the human mind, leading to psychological and interpersonal distress for astronauts. Research has shown that astronauts on long-duration space missions (LDSMs) experience a strong sense of isolation and separation, even affecting experienced astronauts and eliciting feelings of dullness and nostalgia. These negative emotions can result in reduced cognition and performance, posing a potential danger to human health.

However, the understanding of effective solutions for astronauts' mental health is still in its early stages. There is a lack of consensus and standardized terminology for astronauts' mental well-being, and the scientific study of the negative impact on astronauts during long space exploration is limited (Gatti et al., 2022). Addressing astronauts' emotions in the challenging and isolated environment of space is complex and requires further research.

While some individuals may argue that they have the mental fortitude to endure long periods of separation from Earth, the reality is far more intricate. Practical limitations, such as extreme temperatures near Mercury, make it currently impossible for modern technology to facilitate such missions. Similarly, journeys to Mars, taking approximately 2 years, present unique challenges for human well-being (Kuthunur, n.d.). The complex interplay of the human body and mind in space remains beyond complete comprehension by current technology, hindering the full exploration of space by scientists and astronauts alike.

For individuals who express the desire to embark on such missions, they must recognize the immense dedication required, involving extensive training, education, and a commitment of more than 2 years to the vastness of the unknown in space. Thus, the psychological challenges of long-duration space exploration cannot be underestimated, warranting continued research and understanding to ensure the well-being of astronauts in the journey of space exploration.

3. Technological problem

The technological challenge is one of the most widely recognized obstacles in achieving successful long space exploration. The primary goal is to develop a spaceship that can travel at a much higher speed within a year or less, aiming to mitigate the brain and emotional damage caused by extended journeys. Presently, our spaceships travel at a speed of 17,500 mph (*Math and Science at Work - Student Edition,* n.d.), which is only a minute fraction of the speed of light, which can reach up to 700 million mph (Lewis, 2023). In comparison, our current spaceship's speed is a mere 0.000025% of the speed of light. To put it into perspective, this percentage is lower than the likelihood of being struck by lightning in one's lifetime, which stands at 0.00006536% (*Struck by Lightning: What Are the Odds?,* 2022).

While some may argue that reaching the speed of light could potentially enable time travel, the reality is that even the closest habitable planet, TOB 700b, is 200 light years away from Earth, requiring light to travel for 200 years. With our current technology, such a journey would take approximately 8 million years. It is evident that long space exploration to find habitable planets is not feasible. Even the journey to Mars, which has been widely debated, theoretically takes around 9 months (*Trip to Mars - NASA Mars, n.d.*). Yet, numerous challenges lie ahead, apart from the brain and emotional challenges that accompany such journeys.

Building an actual spaceship capable of carrying humans to Mars remains a significant challenge due to limited fuel and resources. A spaceship of the required size to accommodate crew and resources would need to be larger than a football field. Additionally, the varying distance between Earth and Mars as they rotate in the solar system presents a timing challenge. The optimal journey window opens only every 15 years, and the last optimal opportunity occurred in July 2020. Humans must either wait another 12 years for the next optimal window or devise a spaceship capable of overcoming this challenge (Rapp, 2021).

Even if humans manage to develop a stable spaceship within 12 years, the landing poses another obstacle, as a massive dust storm on Mars requires a stable spacesuit that can withstand the conditions. There is uncertainty about the strength of Mars' dust storms, further complicating the task (Rapp, 2021).

Moreover, political and budgetary constraints come into play. With NASA being the most prominent space organization funded by the government, the required technological advancements and constructions would demand a substantial budget. However, NASA's yearly budget is around 25 billion dollars (NASA's FY 2023 Budget, n.d.), which might seem substantial, but it falls short of covering all the necessary technology. Even private companies like SpaceX, founded by Elon Musk, would still face the same challenges, as they are not government-funded (Rapp, 2021).

In conclusion, achieving long space exploration remains a complex and multifaceted endeavor. Overcoming technological limitations, coping with the psychological and emotional impact on astronauts, and managing budgetary and political challenges are essential aspects that require comprehensive research and understanding. As of now, the full realization of space exploration beyond the moon remains an ambitious goal for humanity.

CONCLUSION

In conclusion, the current state of modern engineering does not permit humans to venture beyond the moon for several decades, primarily due to insufficient knowledge of human health in space and technological limitations. Although some individuals may assert that they can still undertake missions past the moon, the question arises: What purpose would it serve if there is nothing substantial to explore in space? Such endeavors would entail a waste of time, effort, and resources, leading to no tangible accomplishments. Instead, the focus should be on further developing engineering capabilities to overcome these challenges and pave the way for reaching Mars and beyond in the future.

The hurdles of long space exploration, including brain and emotional challenges, physiological impacts, and technological limitations, require comprehensive research and innovation. By addressing these critical issues, humanity can lay the foundation for more ambitious space exploration missions, such as reaching Mars and exploring distant planets and celestial bodies. The quest for deeper understanding and exploration of the universe remains an essential aspiration for space agencies and scientists worldwide, and continued advancements in technology and human spaceflight will be vital in unlocking the mysteries of outer space. Until then, the moon remains the farthest frontier for human exploration, and the journey to more distant destinations remains a formidable yet exciting challenge for the future of space exploration.

REFERENCES

1. Gatti, M., Palumbo, R., Domenico, A. D., & Mammarella, N. (2022, May). ScienceDirect. Affective health and countermeasures in long-duration space exploration. Retrieved June 30, from https://www.sciencedirect.com/science/article/pii/S2405844022007022#sec1
2. Kuthunur, S. (n.d.). How Far is Planet Mercury from Earth, and How Long to Travel There? Love the Night Sky. Retrieved July 16, 2023, from https://lovethenightsky.com/how-far-away-is-mercury/
3. Lewis, B. (2023, May 30). What is the speed of light? Live Science. Retrieved July 30, 2023, from https://www.livescience.com/space/cosmology/what-is-the-speed-of-light
4. Math and Science at Work - Student Edition. (n.d.). NASA. Retrieved July 30, 2023, from https://www.nasa.gov/pdf/466711main_AP_ST_ShuttleAscent.pdf
5. NASA's FY 2023 Budget. (n.d.). The Planetary Society. Retrieved July 30, 2023, from https://www.planetary.org/space-policy/nasas-fy-2023-budget
6. Rapp, J. (2021, September 8). Why haven't humans reached Mars? Astronomy Magazine. Retrieved July 30, 2023, from https://www.astronomy.com/science/why-havent-humans-reached-mars/
7. Roy-O'Reilly, M., Mulavara, A. & Williams, T. A review of alterations to the brain during spaceflight and the potential relevance to crew in long-duration space exploration. npj Microgravity 7, 5 (2021). https://doi.org/10.1038/s41526-021-00133-z
8. Second Earth-sized World Found in System's Habitable Zone. (2023, January 10). Exoplanet Exploration. Retrieved July 30, 2023, from https://exoplanets.nasa.gov/news/1720/second-earth-sized-world-found-in-systems-habitable-zone/
9. Struck by lightning: What are the odds? (2022, August 5). NewsNation. Retrieved July 30, 2023, from https://www.newsnationnow.com/weather/struck-by-lightning-odds/
10. Trip to Mars - NASA Mars. (n.d.). NASA Mars Exploration. Retrieved July 16, 2023, from https://mars.nasa.gov/mars2020/timeline/cruise/